Technical Session I

Indian Data Centers for the 21st Century

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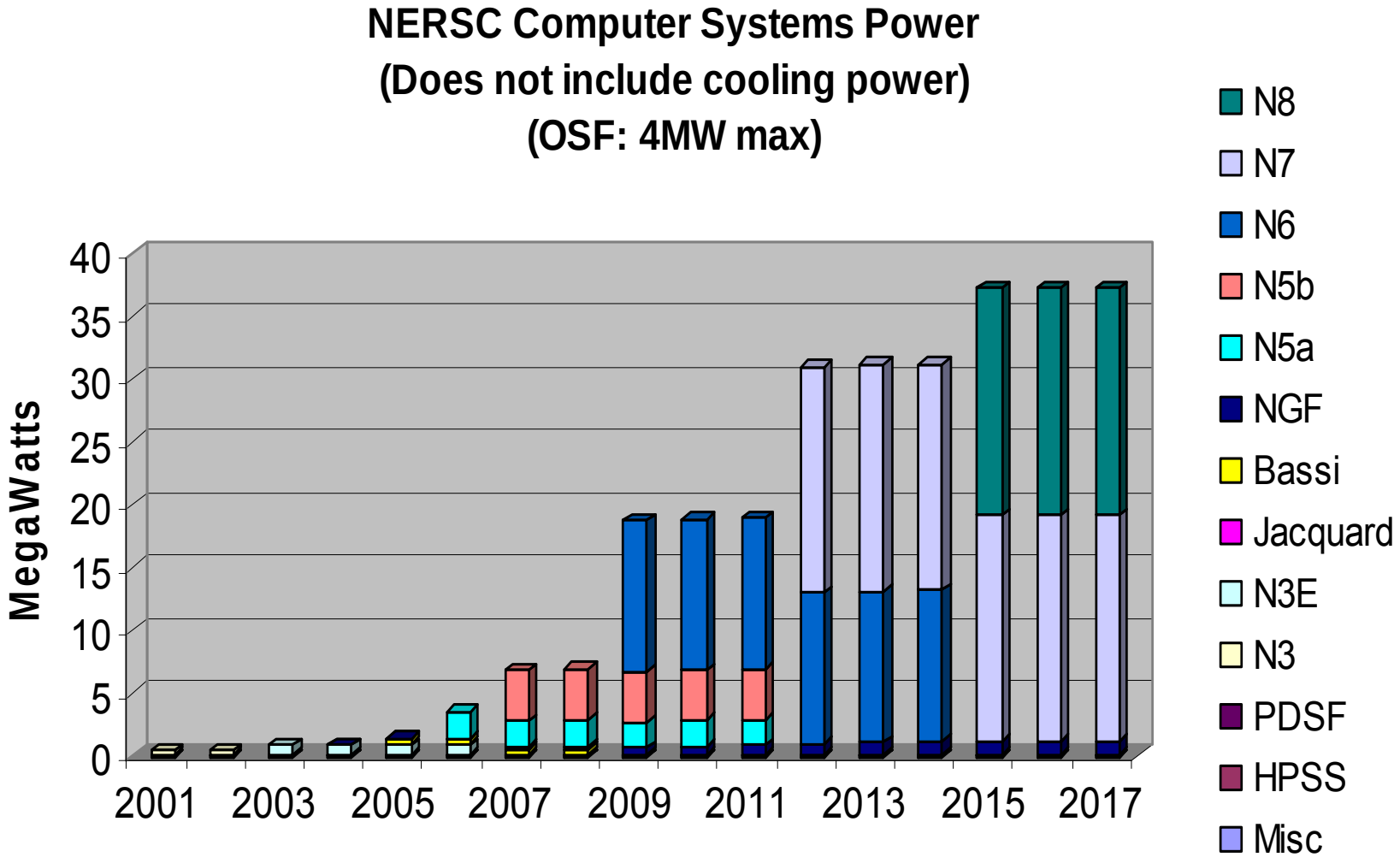
BERKELEY LAB

Topics:

- Feeling the Pain at Home (LBNL)
- Benchmarking Energy Performance
- Industry Trends
- Key Design Issues

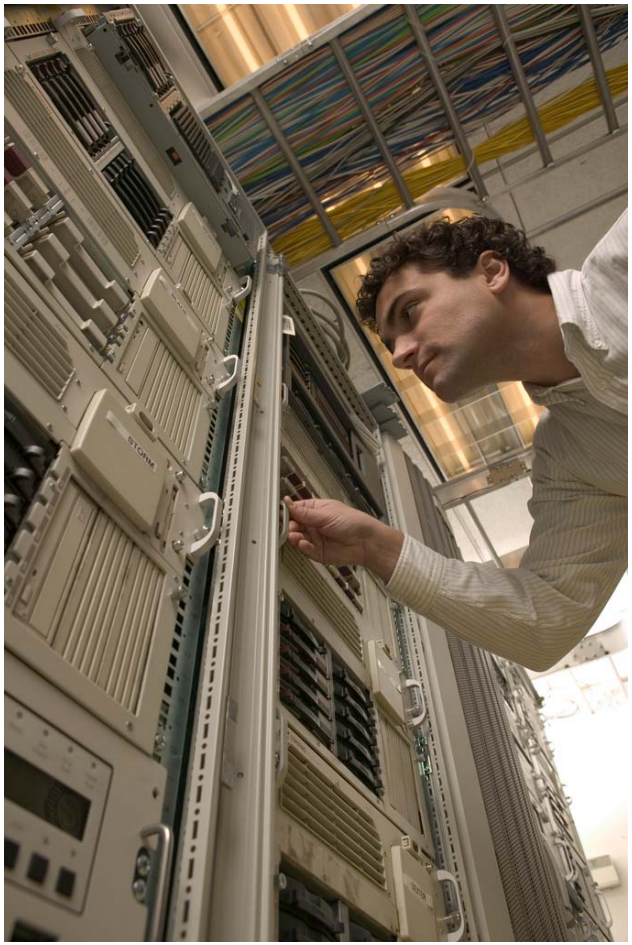
LBNL Super Computer Energy Cost rising 100 fold!

LBNL Super Computer Systems Power:



Potential Benefits of Improved Data Center Energy Efficiency:

- Save billions kWh per year by 2015
- Potentially defer need to build new generating capacity and avoid millions of metric tons of carbon emissions
- Extend life and capacity of existing data center infrastructures
- But is my center good or bad?



Benchmarking for Energy Performance Improvement:

Energy benchmarking can be effective in helping to identify better performing designs and strategies. As new strategies are implemented (e.g. liquid cooling), energy benchmarking will enable comparison of performance.

Benchmarking High-tech Energy Performance:

- Very few tools
- No rating systems akin to EnergyStar
- Building level benchmarks (e.g. kWh/meter2) have limited use
  - Need to normalize for several operational factors
- Need system level metrics and benchmarks to identify specific actions in critical systems

Computational Energy Efficiency Standards:

ENERGY STAR for Servers

- EPA will release strawman proposal this year
- EPA considering power supply efficiency & *system* energy efficiency performance
- EPA also interested in other IT equipment -- storage, networking, etc.

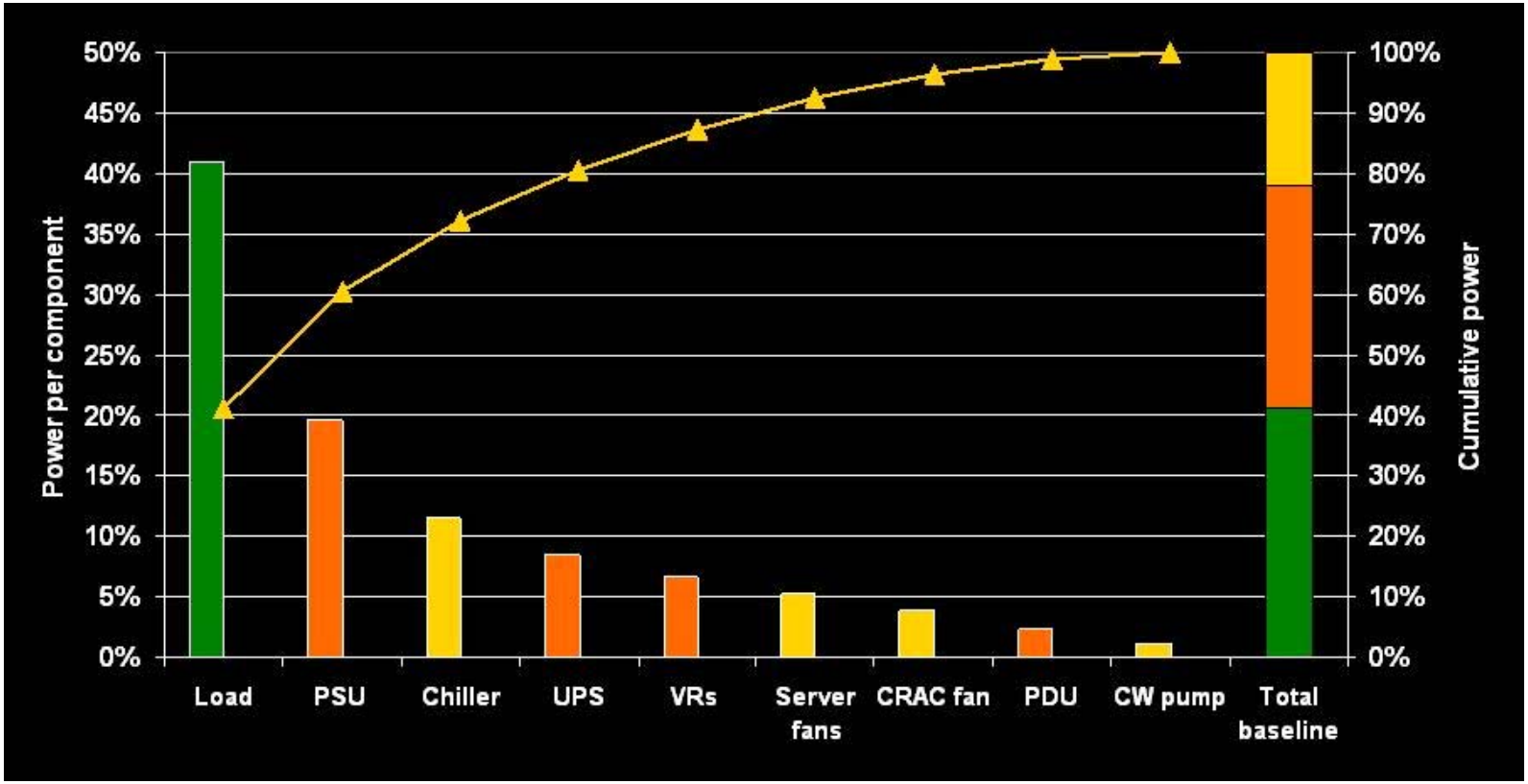
Efforts to Develop Server Performance Benchmark: SPEC

- No metric available to compare server energy efficiency
- SPEC Committee developing energy efficiency benchmark
- Working prototype developed, more info: www.spec.org/specpower

Data Center Metrics (Performance Indicators):

- High-level
  - IT/total
  - useful work/total
- Subsystem
  - Power distribution
  - HVAC
  - Lighting
- Facility performance (other than energy)

Overall Electrical Power Use in Data Centers



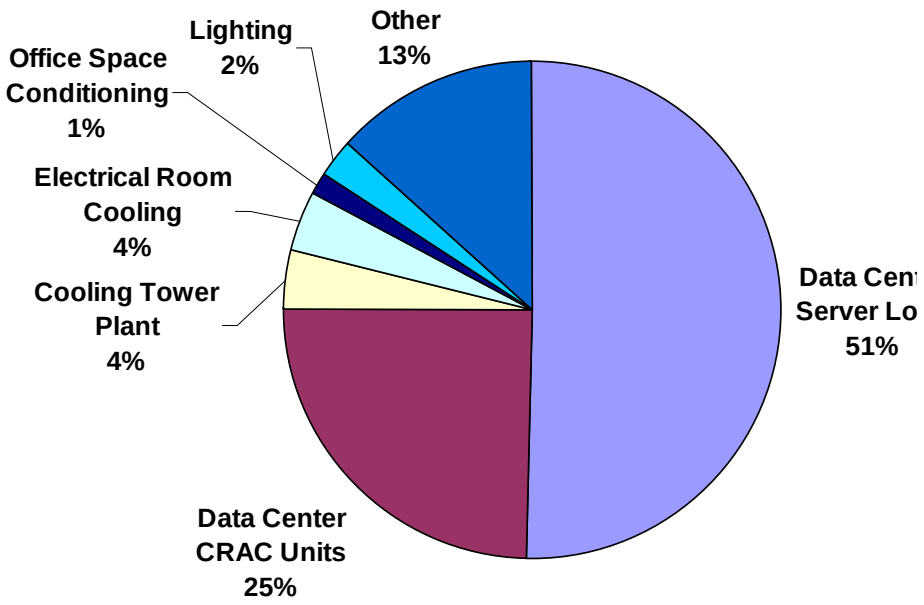
Courtesy of Michael Patterson, Intel Corporation

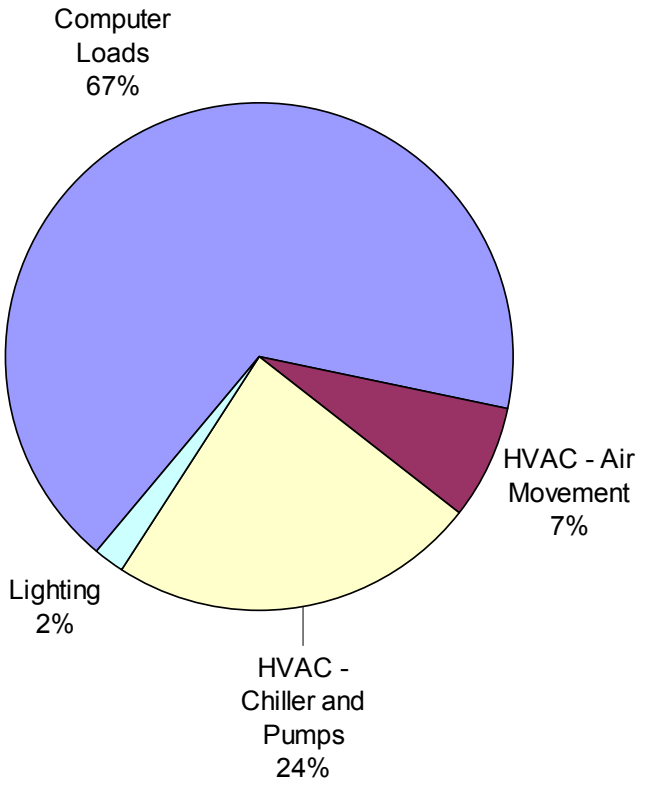
With funding from PG&E and CEC, LBNL conducted benchmark studies of 22 data centers:

- Found wide variation in performance
- Identified best practices

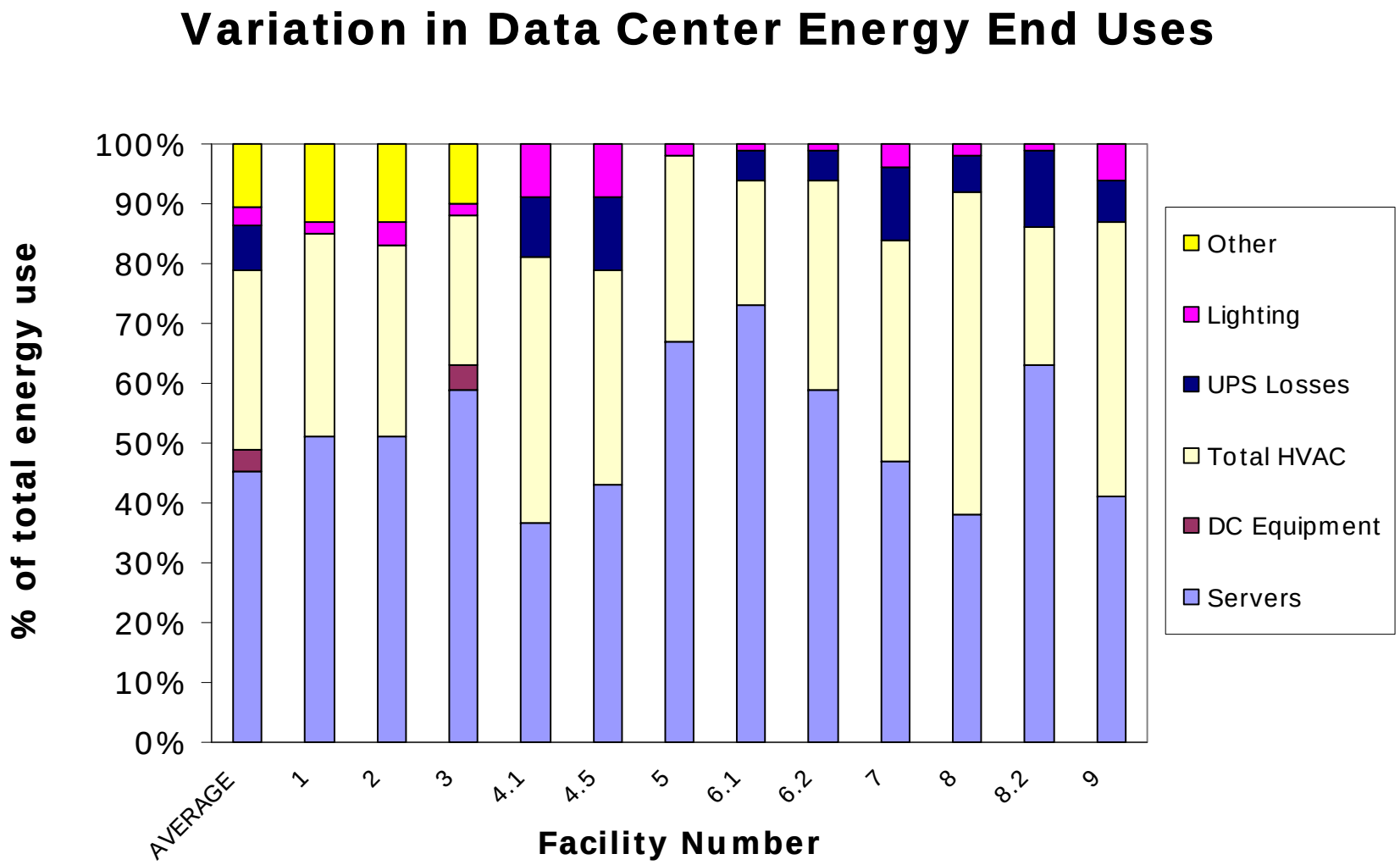
Your Mileage Will Vary

The relative percentages of the energy actually doing computing varied considerably.



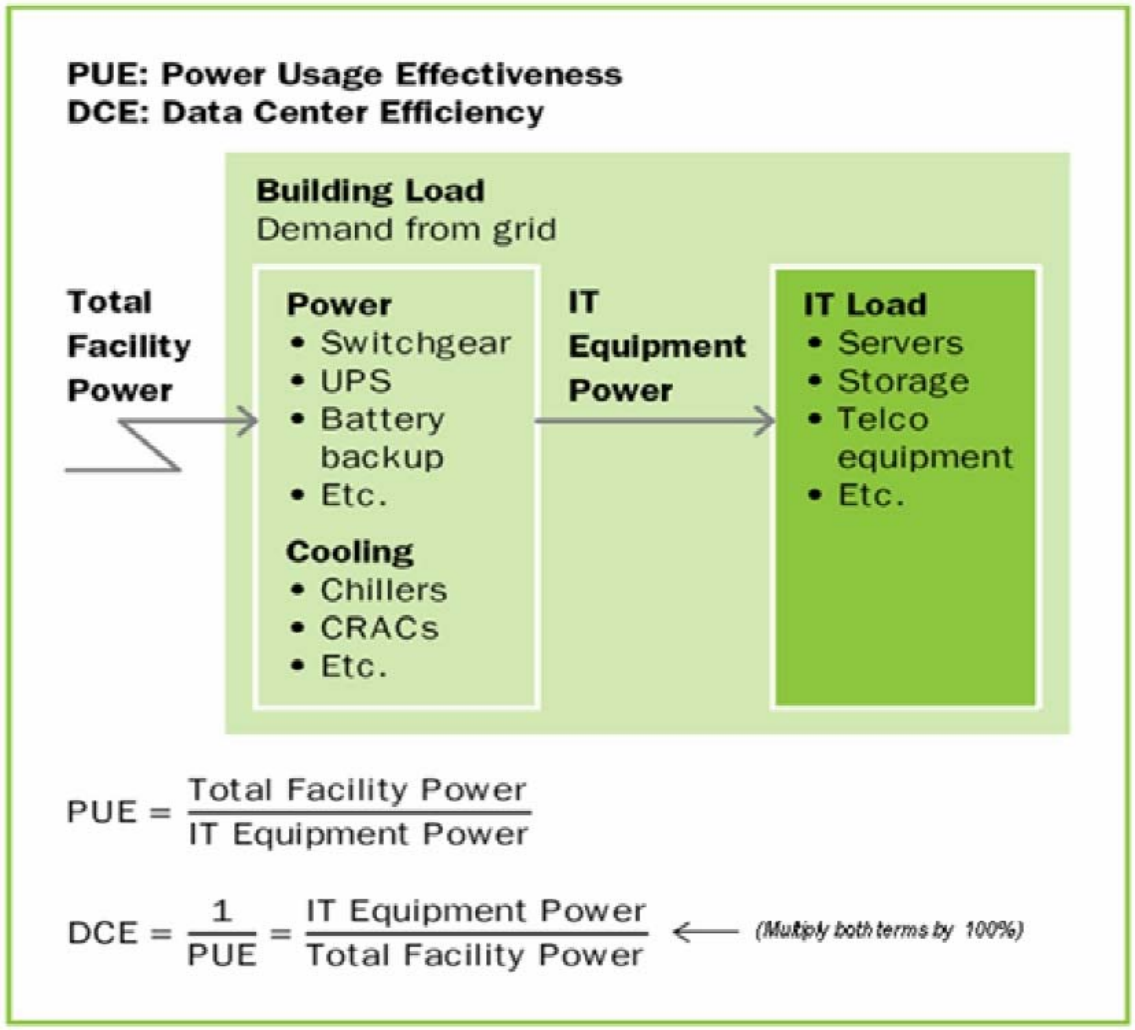


Benchmarking – How do I Stack Up?



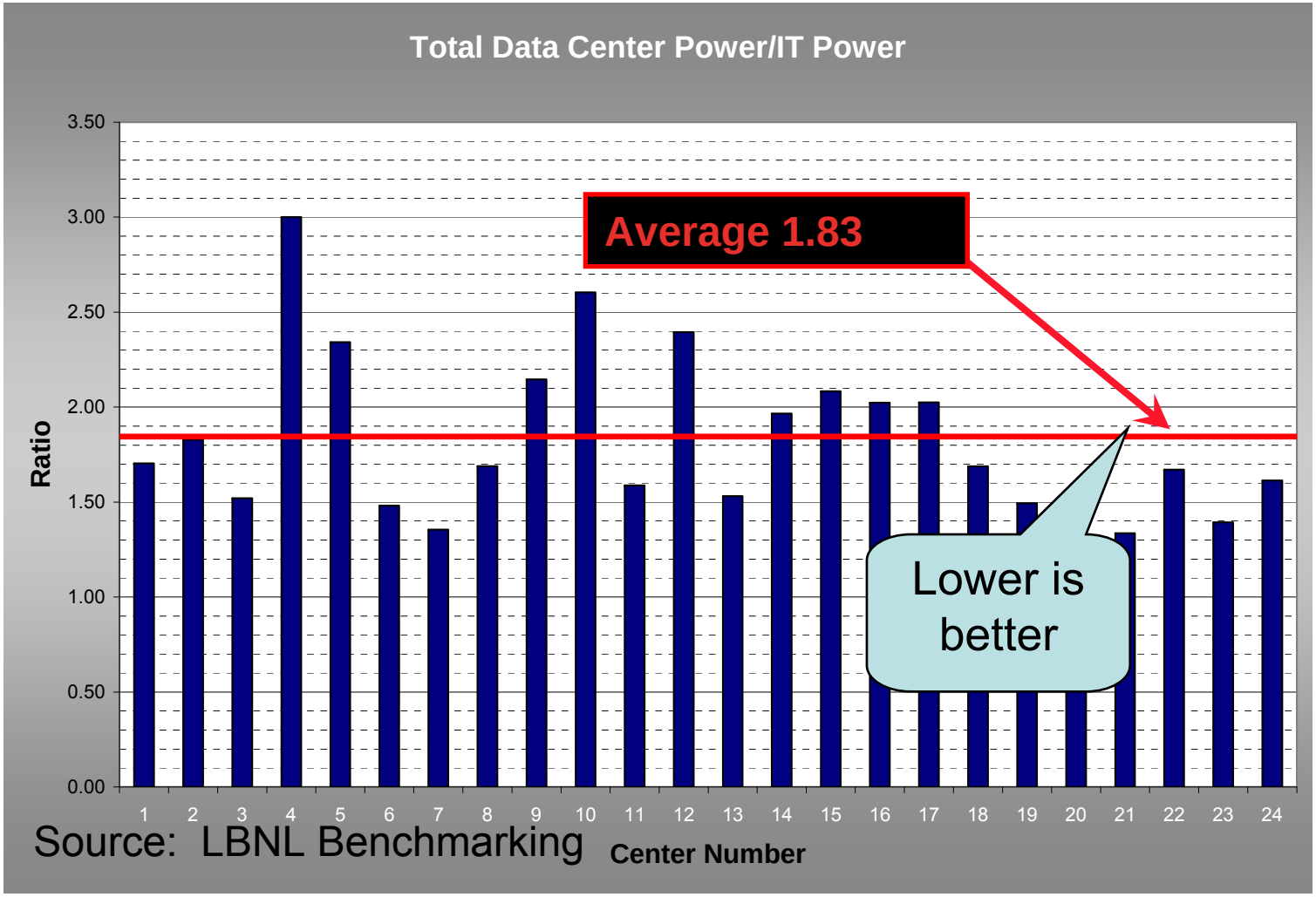
High-level Facility Metrics:

- E.g. Green Grid, PUE and DCiE



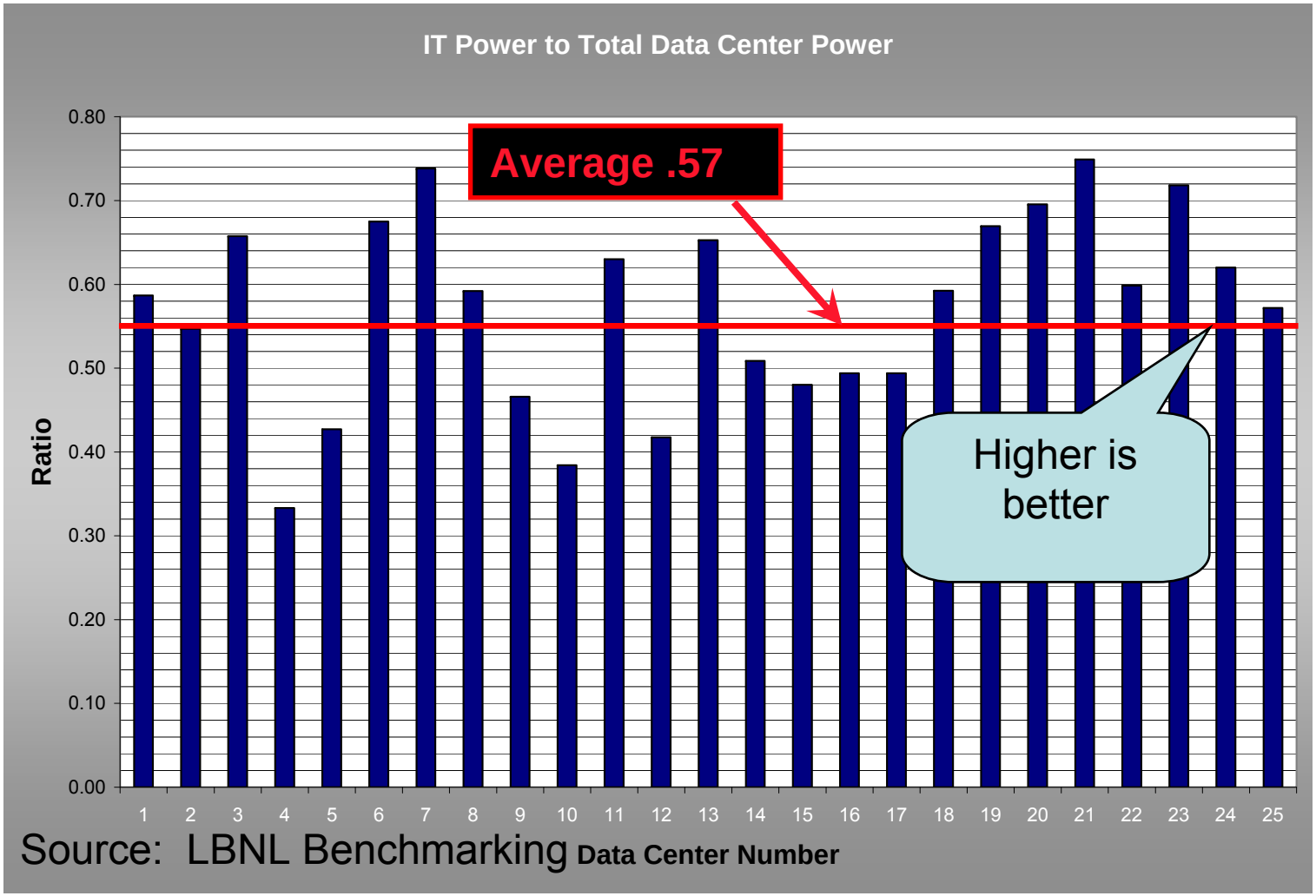
Source: The Green Grid Data Center Power Efficiency Metrics. ©2007.Used with permission

High Level Metric –
Data Center Total / IT Equipment (PUE)



Source: LBNL Benchmarking

Alternate High Level Metric—
Ratio of Electricity Delivered to IT Equipment



Source: LBNL Benchmarking

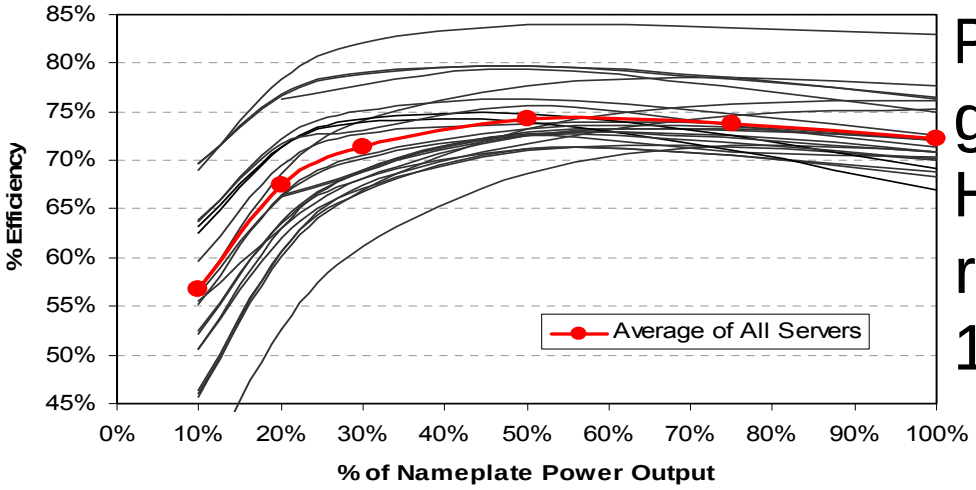
Benchmark Results Help Identify Best Practices

The ratio of IT equipment power to the total is an indicator of relative overall efficiency. Examination of individual systems and components in the centers that performed well helped to identify best practices.

Other Data Center Metrics:

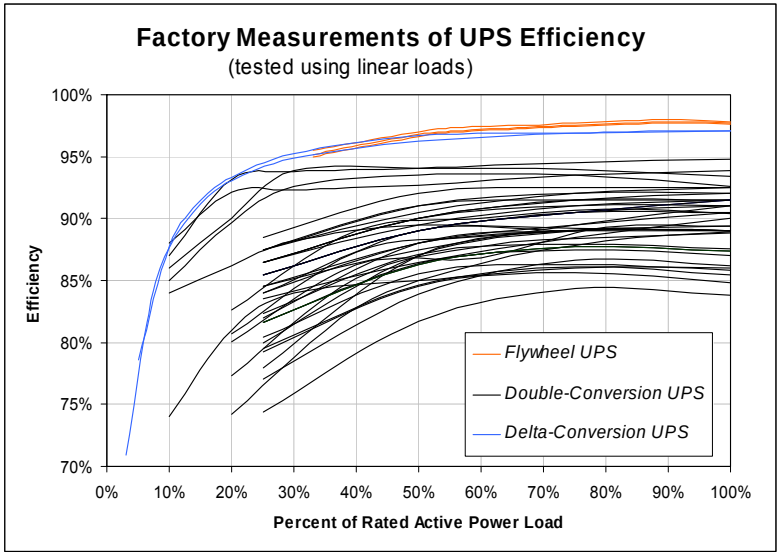
- Watts per square foot
- Power distribution: UPS efficiency, IT power supply efficiency
  - Uptime: IT Hardware Power Overhead Multiplier (ITac/ITdc)
- HVAC
  - IT total/HVAC total
  - Fan watts/cfm
  - Pump watts/gpm
  - Chiller plant (or chiller or overall HVAC) kW/ton
- Lighting watts/square foot
- Rack cooling index (fraction of IT within recommended temperature range)
- Return temperature index (RAT-SAT)/ITΔT

Efficiency of Information Technology Power Supplies and Uninterruptible Power Supplies:



Power supplies in IT equipment generate much of the heat. Highly efficient supplies can reduce IT equipment load by 15% or more.

UPS efficiency also varies a lot.



Rating Systems for Energy Efficient Data Centers - Options:

- Rating system for new data centers based on design criteria
  - CEC developing LEED type rating for data centers
- Recognition program for upper quartile energy efficient performance for existing data centers
  - EPA Energy Star developing rating system for data centers
- Performance label for existing data centers, with requirement for continuous improvement
  - DOE developing facility certification for energy efficiency improvement

DOE Assessment Tool (Under Development):

- Identifies and prioritizes key performance metrics
- Action oriented benchmarking
  - Tool will identify retrofit opportunities based on questionnaire and results of benchmarking
  - First order assessment to feed into subsequent engineering feasibility study
  - See handout for list of questions, metrics, and related energy efficiency measures
  - Input welcome

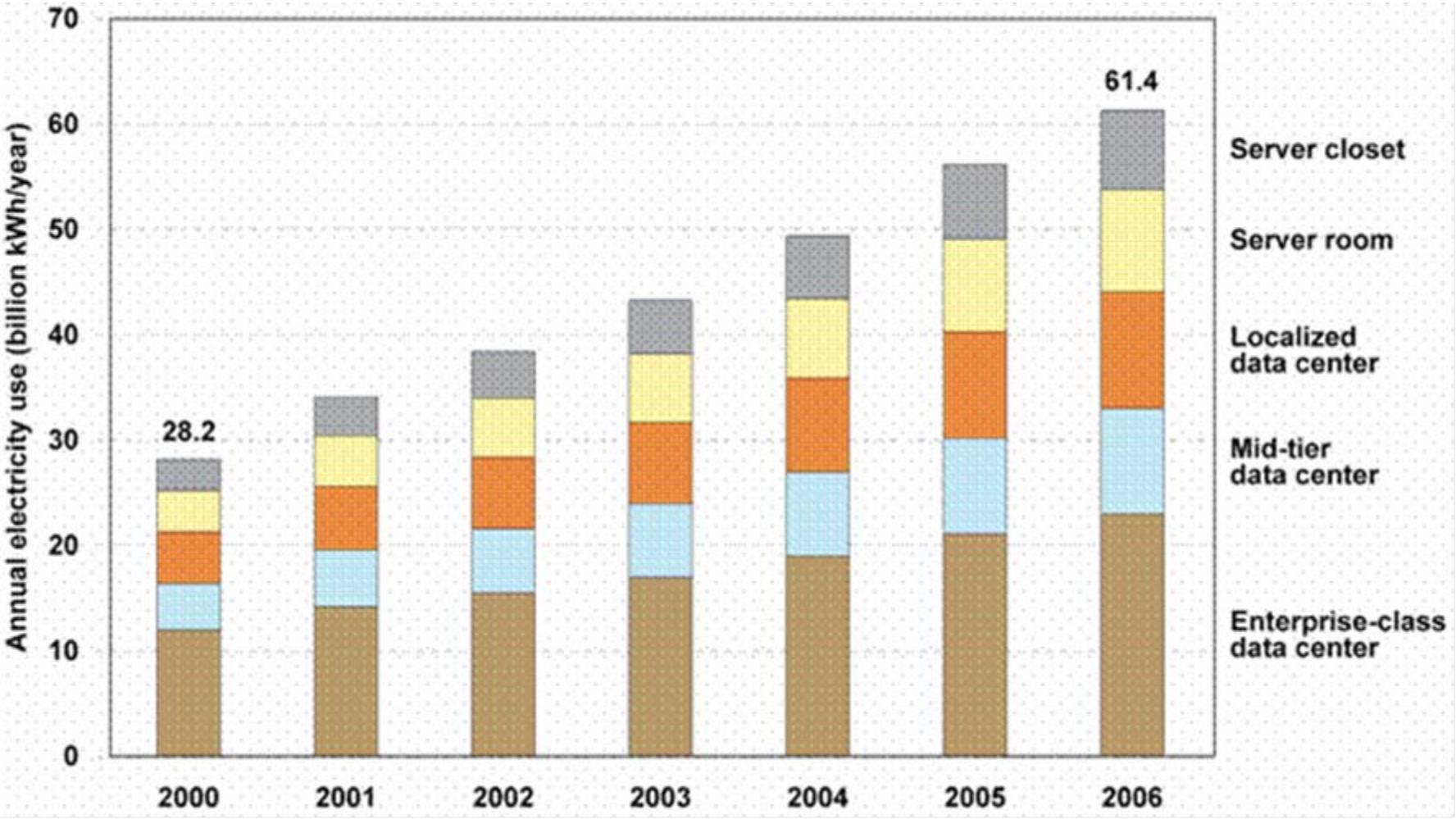
Industry Trends

Data Center Definitions:

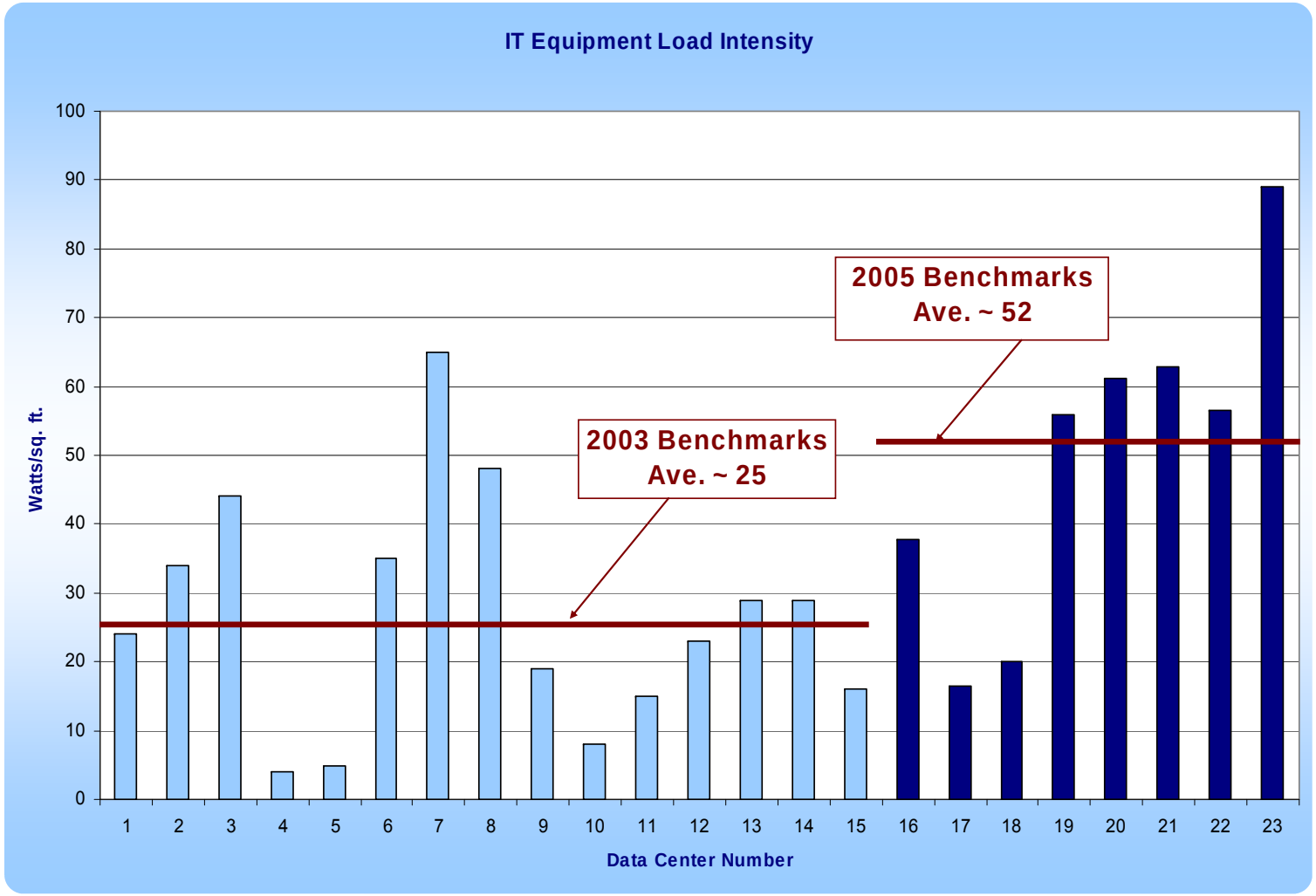
- Server closet < 20 m2
- Server room <50 m2f
- Localized data center <100 m2
- Mid-tier data center <500 m2
- Enterprise class data center 500+ m2

Focus today's workshop on larger data centers—
however most principles apply to any size center

EPA report to US Congress— Breakdown of Space



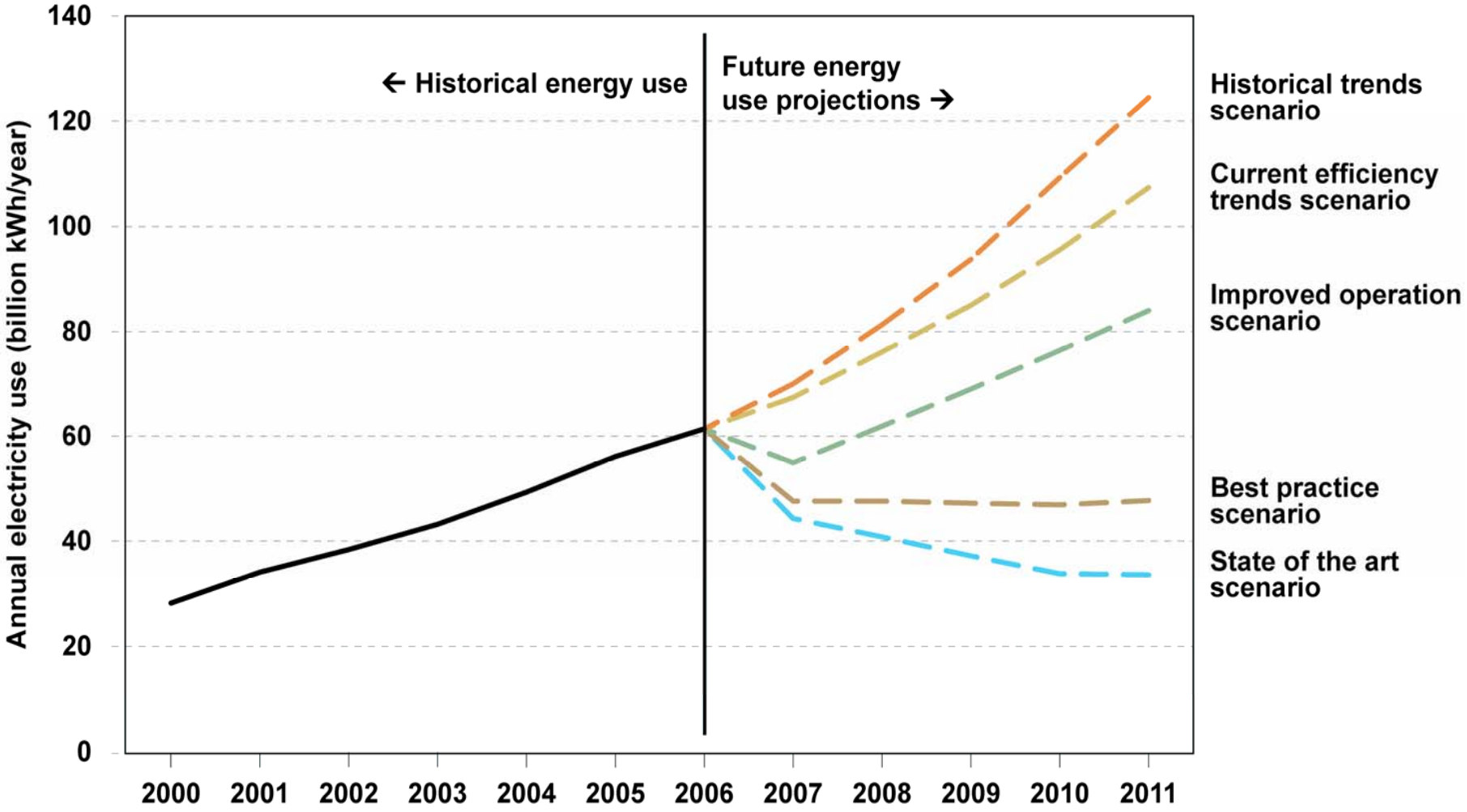
IT Equipment Load Density:



Potential Savings:

- Electrical bill will exceed the cost of IT equipment over its useful life
- 20-40% savings typically possible
- Aggressive strategies can yield better than 50% savings

Scenarios of Projected Energy Use from EPA Report to Congress 2007 - 2011



The Good News:

- Industry is taking action:
  - IT manufacturers
  - Infrastructure equipment manufacturers
- Industry Associations are active:
  - ASHRAE
  - Green Grid
  - Uptime Institute
  - Afcom
  - Critical Facilities Roundtable
  - 7 X 24 Exchange
  - Silicon Valley Leadership Group

IT Industry is Taking Action:

www.climatesaverscomputing.org

the green grid™

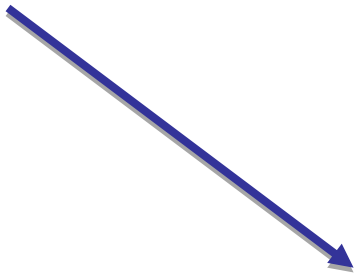
www.thegreengrid.com

More Good News:

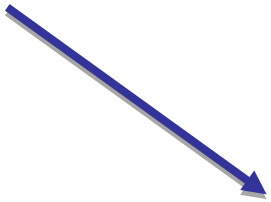
- India specific
  - Some of India's data centers are the best in the world
  - NASSCOM and CII involved in Greening activities
  - BEE has launched energy conservation commercial building code
  - Private/public initiative forming to improve Indian data center efficiency

Data Center Efficiency Opportunities

Benchmarking of over 25 centers consistently lead to opportunities

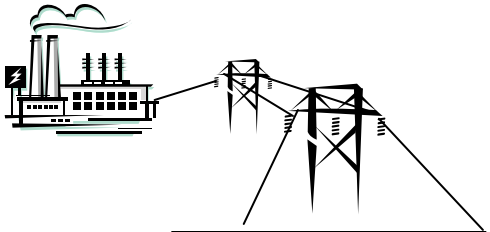


No silver bullet



Lots of silver bb's

Energy Efficiency Opportunities Are Everywhere



Power Conversion & Distribution

- Load management
- Server innovation

Server Load/ Computing Operations

- Better air management
- Better environmental conditions
- Move to liquid cooling
- Optimized chilled-water plants
- Use of free cooling

Cooling Equipment

- High voltage distribution
- Use of DC power
- Highly efficient UPS systems
- Efficient redundancy strategies

Alternative Power Generation

- On-site generation
- Waste heat for cooling
- Use of renewable energy/fuel cells

Take Aways:

- Benchmarking helps identify performance
- Efficiency varies
- Benchmarking suggests best practices
- Large opportunity for savings
- IT equipment loads can be improved